GRAT 0265 UNCLASSIFIED 555

37

LOOSE MINUTE

20194 0265

To : Task Force Commander, Operation Grapple 'X'

Cloud Sampling

1. It is agreed that the meteorological conditions at Christmas Island, although ideal in some ways, pose considerable problems in others. Firstly, the tropopause at Christmas Island varies between 55,000 and 59,000 ft; this is in contrast to the tropopause in the U.S. Eniwetok area which is more usually around 45,000 ft. and, under conditions of small, i.e. under two megaton bursts, may give quite different cloud concentrations. In the Eniwetok area the mushroom tends to leave some cloud at tropopause and then go on up producing a small sample at tropopause level, but the main body being much higher does not cause the problem of "shine" that is caused at Christmas Island where the difference of 12,000 to 15,000 extra feet in tropopause level tends to result in the upward rise of the cloud immediately after this level being slower and the spread immediate thereby causing an embarrassing amount of "shine" to the cloud samplers who must be over 50,000 ft. The other thing which I think must be borne in mind is the temperature at the 60,000 ft. level in the Christmas Island area. If this is minus 90° or over, trouble may well be expected from "flame-out" in rocket assisted turbo-jet aircraft. It is frequently minus 82° at 53,000 ft.

2. We have tended to find in past trials that the area between the base of the cloud and the sea is, to all intents and purposes, free from significant radiation. The stem at 10,000 and 20,000 ft. is also substantially free from fission products which, in air samples, may start to be found at 30,000 ft. and upwards. With the bigger yield weapons (two and over megaton) the same substantially holds, but even at 45,000 ft. the main body of the fission products will not be found, they are quite obviously in the area of 55,000 to 60,000 ft. and above.

3. Arrangements have been made for the employment of Scorpion Canberra B.6's flown by firm's pilots to take part in Grapple 'Y'. This to enable sampling to be carried out at a height of 60,000 ft. Such a plan carries with it at least three main problems:-

(a) By the expected date for Grapple 'Y' only one of these special rocket powered Canberras will be available and will not in any event reach the area until about 'D' minus 7 days.

(b) Apart from the serviceability of such complicated machines on the day there is the fact that the pilot and navigator will not have had much tropical experience in these aircraft and will not have had any experience whatever of cloud sampling. They may therefore find their first cloud sampling operation difficult in this area for, due to lack of acclimatising, excessive perspiration can be very embarrassing by the misting up of the helmet, etc.

(c) For technical reasons connected with Grapple 'Y' the Scorpion Canberra will not be taking off until immediately after the burst, and can therefore not be expected to do its 60,000 ft. sampling run until at least H + 1 hour.

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ENT 2

As stated in the beginning of the letter it is more than probable that there will be plenty of relatively thin cloud left to sample at that height at that time, whilst the much lowered dose rate will enable a straight run through to be made for the full length. But it is felt that they will certainly want a very thorough briefing beforehand and will need ground controlling. Having regard to these difficulties, I think that any samples that the Scorpion Canberra collects must be regarded as a bonus and that there should be no alteration to the existing sampling procedure as carried out on previous Grapple Operations by 76 Squadron. Better and more efficient technical equipment is, I understand, being made available for Grapple 'Y' particularly collimated dose rate meters which will give a more accurate reading of the size of the sample being obtained since they will cut out "shine". The integrating dose rate meters installed in the aircraft, at the request of A.W.R.E. and, against the expressed wishes of those with cloud sampling experience, have proved to be an untrustworthy, expensive and complicated failure since they tend to register on certain H.F. transmissions and for a variety of other reasons quite unconnected with radiation, and I hope to see them either much improved and trustworthy or finally dispensed with from R.A.F. sampling aircraft.

5. If the conditions met on Grapple 'X' are found to coincide with those occurring on Grapple 'Y', i.e. that the recorded dose rate at H + 15 minutes is only of the order of 300r per hour for a two diagnostic run at 48,000 ft. then I can see no reason why the aircraft should not then made a cloud penetration straight away. This penetration coupled with those of two other aircraft later at H + 30 and H + 45 minutes should give better results than were obtained on Grapple 'X' (that these results were in fact the barest minimum is realised but it is stressed that this minimum was collected by really only two aircraft, with this technique it might reasonably be expected to be increased by at least a factor of 50%). The Scorpion Canberra can then make its high level pass without any other aircraft in the area but, for various reasons, I think it would be unwise to place too much reliance on the amount expected from it.

[redacted]

C.M.E.
22.11.57

[redacted]

Copies to : Scientific Director, A.W.R.E. (3 copies) (1 - Director, 2 - D.D., 3 - C.R.)
[redacted] (2 copies)
H.Q. Task Force Grapple 'Y' (3 copies)

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P 34

~~CONFIDENTIAL~~

From: [redacted] Health Controller, A.W.R.E., Christmas Island

To: O.C 76 Squadron, Royal Air Force, B.F.P.O. 170

Copies to: See Distribution List

Date: 2nd May, 1958

Ref: RM/1

Radiation Doses

1. Arising from the operation on 28th April, 1958 a number of members of 76 Squadron received doses greater than 3 r and consequently their future exposure to radiation has to be controlled. The rules governing exposure to radiation are contained in "Radiological Safety Regulations, Christmas Island" paragraph 2.1.

2. The Officers concerned are:-

Name	Dose received	Date further exposure may commence without special authority
[redacted]	10.75 13.0 10.75 13.0 10.5	28.4.61
	10.0	15.12.58
	7.5	20.10.58
	5.0	25.8. 58
	5.5 ✓	8. 9.58
[redacted]		

Distribution:-

Task Force Commander
S.A.S.O.
[redacted] (for Air Ministry Medical Directorate MA4)
Trials Director
Trials Superintendent
[redacted]
Group Leader RM Group
[redacted]
Spare (2)

~~CONFIDENTIAL~~

GY/7/RM
Copy No. 3 of 4 Copies
Consisting of 11 Pages

~~TOP SECRET~~ [redacted]

[redacted]

OPERATION GRAPPLE-Y

INTERIM REPORT

PART 7. RADIOLOGICAL MEASUREMENTS

[redacted]

With Statements on Health Physics Control by

[redacted]

(Decontamination Area)

Contents

The members of the Group were:

[redacted]

Trials Planning Branch,
A.W.R.E.,
Aldermaston, Berks.

June, 1958.

~~TOP SECRET~~ [redacted]

GY/7/RM

~~TOP SECRET~~ [redacted]

Copy No. of Copies
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OPERATION GRAPPLE-Y - INTERIM REPORT

PART 7. RADIOLOGICAL MEASUREMENTS

1. Statement of Group Tasks

RM1 To measure the integrated gamma dose/distance relationship, and the variation of dose rate with time for the initial gamma radiation.

RM2 To measure the variation of integrated neutron flux with distance.

RM3 To measure fallout contamination at points close to Ground Zero.

RM4 To measure fallout at surrounding islands.

RM5 To measure the gamma dose in cloud sampling aircraft.

RM6 To advise on health physics and radiological control.

RM7 To provide a dose measuring service.

RM8 To provide nuclear instrumentation.

RM9 To radiograph and monitor the neutron output of weapon components.

RM10 To carry out a radiological survey and the analysis of a sea water sample from surface zero.

RM11 To make radiological survey in an emergency.

RM12 To arrange for fish monitoring.

~~TOP SECRET~~ [redacted]

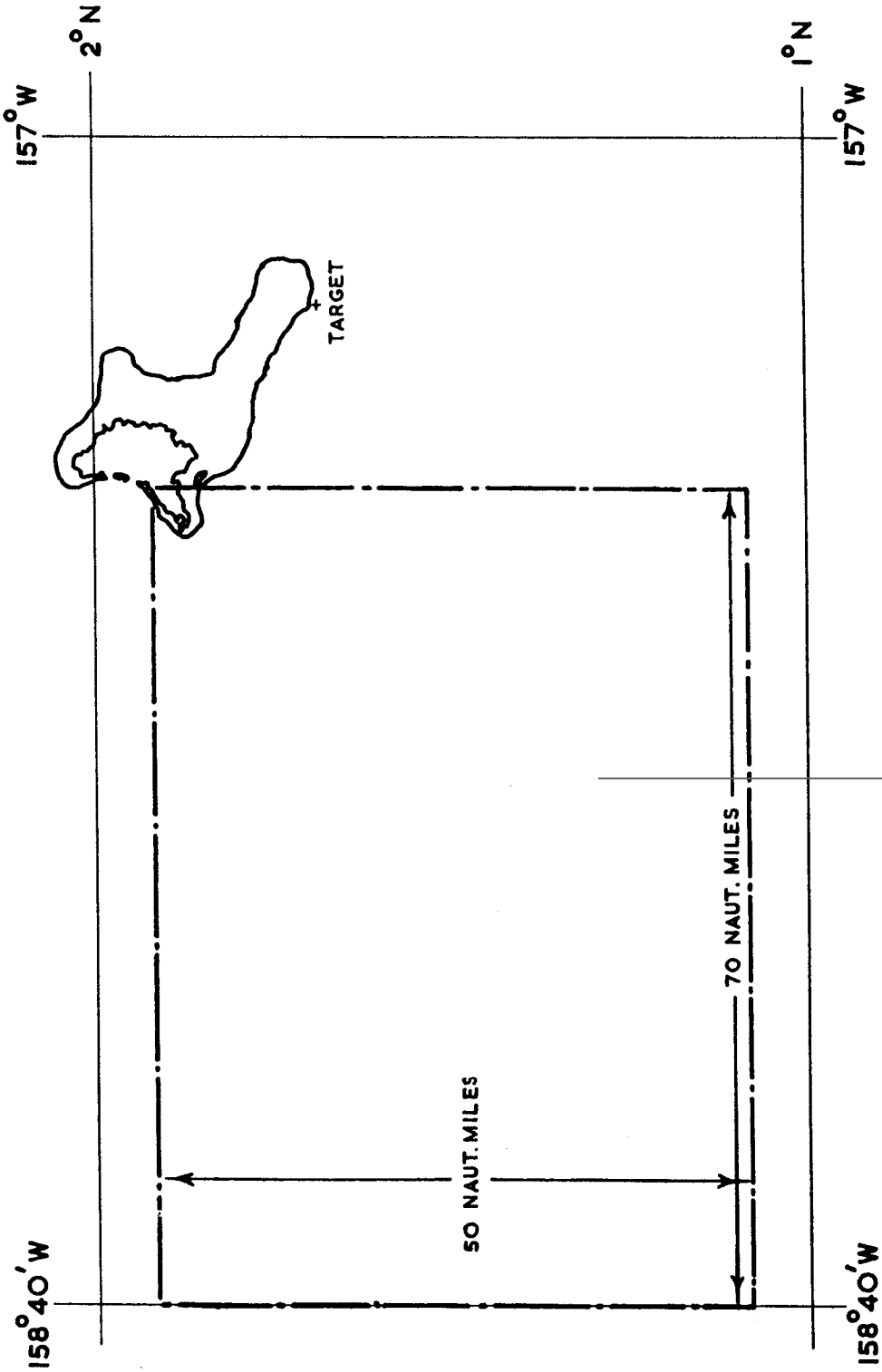

FIGURE 1 (TP) AREA OF AERIAL RADIOLOGICAL SURVEY

Reference SRHP/H.7006

[redacted]

Film Doses - Grapple Y

(Shielded)

1. Attached as annexures to this letter are the dosages in roentgens incurred by AWRE and service personnel on Grapple Y.

2. A few results are still to come. They are contained in some paperwork which has not yet returned from Christmas.

[redacted]

Building [redacted]
Extn. [redacted]
4th June, 1958.

c.c. Air Ministry (for Grapple P and MA 4) with Annexure B and C
O.C. 76 Sqdn. RAF with Annexure B
O.C. 240 Sqdn. RAF with Annexure B
O.C. 38 CORPS REGT R.E. with Annexure A

[redacted]

17/6/58.

(11)
duplicate
18

R.A.F.

Annexure B

76 Squadron

	Dose (Roentgens)
[redacted]	0.45
	0.35
[redacted]	0.38
[redacted]	13.0
	10.75
	5.0
[redacted]	0.34
	13.0
	10.0
	10.5
	10.75
	0.07
	7.5
	5.5

240 Squadron

[redacted]	0.020
	0.020
	0.020
	0.020
	0.070
	0.020
	0.020
	0.030
	0.080
	0.070

Helicopter Squadron

[redacted]	0.020
	0.030

[redacted]

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[redacted]

804

806

[redacted] Group Leader TP Group.

GRAF 1034

CINO 0270 0399

In the Flagpole sampling sorties three Canberra crew members received radiological doses considerably in excess of the 10r authorised for this exercise and it is necessary that this should be investigated.

[redacted]

You have been nominated to take charge of this investigation, which should be completed as soon as possible. Your terms of reference are:-

"To investigate circumstances in which the crew of sampling Canberra No. WH 976 exceeded their authorised radiological doses on Flagpole sampling and to recommend immediate steps to prevent a recurrence during Grapple Zulu."

You will be assisted in your enquiry by [redacted]

[redacted]

Scientific Director

J.O.C.
3 September 1958

c.c. [redacted] (for info)

[redacted]

UNCLASSIFIED std-Cat.

[redacted]
Scientific Director.

WH 0/0 1

Flagpole - Sampling by Canberra No. WH 976

In accordance with your letter of 3rd September, I have investigated the circumstances in which the crew of sampling Canberra No. WH 976 exceeded their authorised radiological doses on Flagpole sampling; and I have considered what immediate steps should be taken to prevent a recurrence during Grapple Zulu.

I have discussed the matter with [redacted] and [redacted] I have not talked with the crew of the aircraft, believing that they could shed no further light, and thinking that anything suggestive of a formal enquiry would only cause them needless anxiety.

Herewith my report and recommendations.

1. The Instruments

For the sake of completeness it is useful to begin by listing the radiation instruments carried in sampling aircraft. I use the code names that are employed during the sampling process.

Romeo	:	gives dose rate
Charlie	:	gives total dose
Salmon	:	indicates success of sampling

In addition, each member of the crew has a personal film badge and a personal quartz fibre dosimeter, both indicating total dose, the first after development and the second by an immediate meter reading.

2. The Men

Three men are involved in the control of each sampling aircraft, viz., the Captain of the aircraft, Sniff Boss, and Sniff Controller. Sniff Boss is the accepted term for the airborne sampling controller [redacted] Flagpole): for the sake of brevity in this report I have invented the term Sniff Controller for the ground-base sampling controller [redacted] at Flagpole).

In broad terms Sniff Boss directs each aircraft during the sampling process, and Sniff Controller exercises a general supervision through Sniff Boss. The Romeo, Charlie and Salmon readings are transmitted by each aircraft to Sniff Boss and Sniff Controller; with one exception, the Captain of the sampling aircraft takes no action based directly on his interpretation of the readings of his radiation instruments. The exception is that, if his Charlie reading reaches 8r, he immediately takes his aircraft out of the radioactive region and awaits instructions from Sniff Boss.

3. The Events at Flagpole

Three sampling aircraft were employed at Flagpole, Sniff 1, Sniff 2, and Sniff 3. In chronological order, sampling runs were made as follows: one run by Sniff 1, one by Sniff 2, one by Sniff 1, and six by Sniff 3. It was during these last six runs that the crew of Sniff 3 (Canberra No. WN 976) exceeded their authorised doses.

The Appendix gives the Romeo, Charlie and Salmon readings reported at the time by Sniff 3, from which it is seen that, in spite of quite high Romeo readings (of dose rate) the final Charlie reading (of total dose) was only 8.5r, which is less than the permitted maximum of 10r. Calculation

of the total dose by integration of the Romeo readings gives a value of 17r; thus the Romeo and Charlie readings are significantly inconsistent. Later development of the film badges gave values of total personal dose varying from 25r to 30r; and reading of the quartz fibre dosimeters gave values ranging from 16r to 24r. Finally, a check of the Charlie meter has shown it to be defective owing to leakage of air at the low ambient pressure existing in the aircraft at the time of sampling. It is believed that this would result in the Charlie readings being low by a factor of about 3; when allowance is made for this, the value of 8.5r is corrected to 25r. In short, allowing for the effect of air leakage, we have the results:-

Corrected Charlie	:	25r
Film Badges	:	25r to 30r
Dosimeters	:	16r to 24r
Integrated Romeo	:	17r

4. Conclusions

4.1 It is certain that the permitted maximum of 10r was exceeded, but the actual value is less certain, in the absence of detailed experience of the accuracy of the various measurements. The integrated Romeo value will be low because readings are available only for the periods when the aircraft was passing through radioactive cloud: there is a suggestion that readings were "very low" for the remainder of the time, but no great weight can be attached to this. On the other hand, Sniff 1, after completion of his last run, reported a final Charlie reading of 10.9r which may be compared with a value of 6.9r deduced by integrating his available Romeo readings. It is conceivable that part, at least, of the discrepancy of 4r was acquired when the Romeo meter was not being read. The experience of Sniff 2 suggests the same possibility. At exit from the cloud he reported a Charlie reading of 2r, followed by a final Charlie reading of 3r, later corrected successively to 7r and 8.1 r, the final value. Integration of the recorded Romeo readings gives a total dose of 3.1r, i.e. practically the same as his first report of the final Charlie reading. From these facts I conclude that, unless reading of the Romeo meter is continued even when the aircraft is apparently outside the radioactive cloud, a discrepancy of several roentgens can arise between the actual total dose and the value deduced by integrating the Romeo readings. I arbitrarily allow 3r in the present case, thereby obtaining a corrected integrated Romeo value of 20r. Taking the average film badge reading as 27r, and the average dosimeter reading as 20r, I accept $(25 + 27 + 20 + 20)/4 = 23$r as the probable dose received by the crew of Sniff 3.

4.2 I can see no way in which the defect in the Charlie meter, the primary cause of the incident, could have been detected during the sampling operation.

4.3 The question arises as to why the discrepancy between the Charlie readings and the implications of the Romeo readings was not appreciated by Sniff Controller or Sniff Boss. It is clear, after the event, that sufficient information existed at the time of sampling to show that something was significantly wrong.

The answer is that the discrepancy was appreciated qualitatively, but not quantitatively. And the reason for this lies in the fact that, the samples obtained by Sniff 1 and Sniff 2 being thought to be very poor, both Sniff Boss and Sniff Controller were preoccupied with the consequences of poor sampling by the remaining aircraft, Sniff 3.

/4.4

4.4 The question arises as to what action would have been taken had it been thought by Sniff Boss and Sniff Controller that the permitted dose of 10r had been reached while only very poor samples had been achieved. There is some uncertainty here concerning the application of the appropriate sections 3.1.1(c) and 3.1.1(d) of "Radiological Safety Regulations: Christmas Island". I believe that Sniff Controller, if unable to obtain an immediate ruling, might have thought himself forced to decide whether the success of the trial warranted a dose greater than 10r.

4.5 In the time available, little can probably be done to improve instrument reliability for the remainder of Grapple Zulu. If possible, the Charlie meters should be enclosed in a pressurised box which would prevent the same defect occurring again; but action should be taken on the assumption that this modification cannot be carried out: if it can, so much the better.

5. Recommendations

5.1 Rather than rely solely on the Charlie meter to obtain total dose, more use should be made of the personal dosimeters and the Romeo meter. To this end the readings of the dosimeter of one crew member should be transmitted to Sniff Controller at, say, two minute intervals while the aircraft is on a sampling run.

5.2 The readings of the Romeo meter should be continued even when the aircraft is not thought to be in a radioactive cloud. To avoid interrupting the commentary from another aircraft actively engaged in sampling, the readings in a passive aircraft might be recorded within it for later transmission at the commencement of an active run.

5.3 Probably the most immediately useful single step to avoid a recurrence is one of organisation. At present both Sniff Boss and Sniff Controller have two responsibilities, to see that adequate samples are obtained and to ensure that the maximum permitted dose is not exceeded. Rather than both men sharing both duties, each should take one as his primary concern, Sniff Boss planning the sampling runs, while Sniff Controller devotes himself mainly to assessing the total dose experienced by each aircrew.

5.4 In order to make most use of the Romeo meter, Sniff Controller should maintain a record of the total dose as estimated by roughly integrating the Romeo readings as they are announced. With Sniff Controller relieved of the planning of sampling runs, he can perhaps do rather more to this end than calculate mentally the changing average dose rate, from scrutiny of the Romeo numbers. In particular, he might find it easier to assess the total dose by scrutiny of a graph of the changing Romeo readings against time. Quite rough quantitative assessment of this sort would have revealed that something was wrong during the sampling of Flagpole by Sniff 3: sufficient would have been revealed to have made it prudent to withdraw the aircraft without knowing the cause of the trouble. The samples might then have been quite inadequate.

5.5 The matter of the permitted maximum dose needs to be clarified. This might be by a specific instruction to the Sniff Controller prior to each burst. On the other hand it is my reading of the Safety Regulations that the absolute maximum for this purpose has already been laid down as 10r in section 3.1.1(c). In any case it seems essential that any special discussion and authorisation of the sort contemplated in section 3.1.1(d), if it applies, should precede the burst.

5.6 I have not detailed recommendations which are minor and whose implementation is under way as a result of discussion; nor those that could not be implemented in the remaining period of Grapple Zulu. In the first category are investigations directed to checking the film badge estimates. In the second category are suggestions that the Salmon meter stands in need of

/substantial

substantial improvement; that the scale of the 600r per hour Romeo meter should be made less confusing to read in the vicinity of one-quarter of full scale; and that all Romeo meters should read in roentgen per minute instead of roentgen per hour.

[redacted]
Group Leader TP Group

J.O.C.
6 September 1958

APPENDIX

Readings of the Radiation Instruments in Canberra No. WH 976

Romeo readings are in roentgen per hour, Charlie readings are in roentgen, and Salmon readings are in arbitrary units in which 50 is full scale deflection of the meter.

Instants at which readings were reported are numbered consecutively in chronological order; the interval between consecutive readings on a given run is 15 seconds throughout.

The true height of the aircraft was 54,000 feet on all runs.

Run 1

Time of entry = H + 87 min. Time of exit = H + 89 min.

Instant	1	2	3	4	5	6	7	8
Romeo	40	150	160	160	170	180	190	180
Charlie	0	0	0	0	0	0	0	0
Salmon	0	0	0	0	0	0	0	40

Final Charlie = 1.5

Run 2

Time of entry = H + 93 min. Time of exit = H + 95 min.

Instant	1	2	3	4	5	6	7	8
Romeo	120	110	120	110	120	90	40	50
Charlie	2.0	1.8	1.8	2.0	2.2	2.5	2.6	2.6
Salmon	20	3	15	26	46	50+	50+	50+

Final Charlie = 2.8

Run 3

Time of entry = H + 102 min. Time of exit = H + 104 min.

Instant	1	2	3	4	5	6	7
Romeo	60	80	90	100	120	130	130
Charlie	2.6	2.6	2.8	3.0	3.0	3.3	3.5
Salmon	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 3.6

Run 4

Time of entry = H + 108 min. Time of exit = H + 110 min.

Instant	1	2	3	4	5	6	7
Romeo	70	100	120	100	80	80	80
Charlie	4.3	4.5	4.8	4.8	5.0	5.2	5.3
Salmon	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 5.5

/Run 5

CINO 09378

833

Determination of the whole body dose of Radiation acquired by Aircrew members while on Cloud Sampling detail with special reference to the use of the Standard Film Badge and Cassette

RAISON D'ETRE

Scientific

To outline the present methods of crew dosage assessment with special reference to the use of film badges and to suggest possible fallacies, discrepancies and improvements that might be made in future.

Domestic

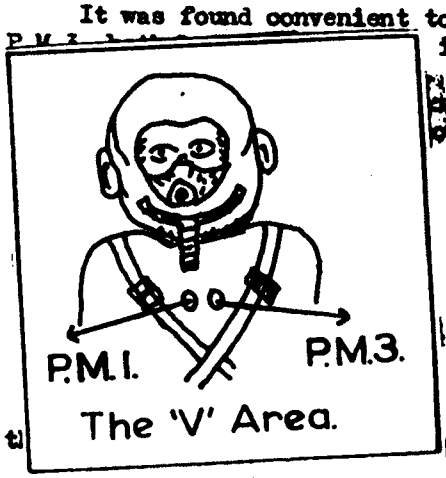
To attempt to minimise future crew wastage rate due to members being discarded on the evidence of doubtful dosage evaluation.

PAST DEVELOPMENT

In the initial trials only one film badge was carried per crew member - Canberra B6 aircraft normally carry a crew of three. Badges were not worn over any specific area of the body and the shielding effects from the aircraft body and equipment were anything but constant.

On all trials sampling has been invariably carried out by more than one aircraft, but as the time of sampling in relation to burst and duration "in cloud" are not constant, the range over which a badge has to record has varied very greatly, and it soon became apparent that, to cover the possible range, more than one type of badge would have to be worn by each individual.

It was found convenient to support the initially used P.M.1 film badge with a P.M.3 badge in the "V" area. It will be seen in the illustration that this area of the person is not covered by any item of aircrew equipment such as parachute buckles, and also, while in the sitting position, it was thought to give a fair approximation of whole body dose; as it is known that the sitting height, on the average, varies by less than three inches for average crew members.



The 'V' Area.

The advantages gained by this simple standardisation of film badge technique were:-

(1) Uniformity of badge position;

(2) External shielding was avoided from flying harness etc.;

(3) The dual badges (P.M.1 and 3) ensured that an adequate range was covered and where overlap occurred a check could be obtained.

Note: For the purpose of this paper it is considered that a P.M.1 covers from 0·1r to 6r and a P.M.3 from 1r to 20r. These ranges are those at which the readings are reasonably accurate and at which independent readers would produce similar answers from the film graphs, i.e., the upper and lower limits of the range of each badge are excluded.

As a further insurance all crew members have carried pocket dosimeters, initially reading from 0 - 0.5 r, but later the higher reading 0 - 50 r instruments were adopted. Fair agreement was found to exist between badges and dosimeters, though the latter, as a rule, tended to read low. Dosimeters have normally been carried in the left leg-pocket of the flying overall, being then at approximately mid-tibial level. Though a valuable check and useful for immediate assessment on

It was found convenient to supplement the initially used P.M.1 film badge with a P.M.3, both badges being worn in the "V" area. It will be seen in the illustration that this area of the person is not covered by any item of aircrew equipment such as parachute buckles, and also, while in the sitting position, it was thought to give a fair approximation of whole body dose; as it is known that the sitting height, on the average, varies by less than three inches for average crew members.

It was considered that by this simple standardisation of film badge technique the following advantages were gained:-

(1) Uniformity of badge position;

Note: This is the text which lies underneath the drawing on the previous page.

landing, dosimeters are not considered either accurate or reliable, particularly in wet humid climates where the leak rate can be considerable. No convenient method of carrying dosimeters in the mid-body position has yet been devised for aircrew in full flying clothing.

A further check on general dosage is ensured by a fixed integrating dosimeter consisting of a moderately large and well insulated ion chamber. This instrument is known in the Service as the "Charlie" meter, and is located under the rear right seat of the aircraft. A large, easily read scale, an important factor in the dim light of the cabin, is located on the right rear instrument panel, and allows the wireless operator to note the mounting dose and transmit this information to the pilot of the aircraft and controllers on the ground and in the air. In operation this instrument has proven itself to be most reliable and the dosages recorded have been in fair agreement with the film badges and the pocket dosimeters. One difficulty has, however, arisen, in that the instrument can effect certain electrical instruments in the aircraft. This hazard has been eliminated.

From the three methods outlined above - badge, dosimeter and integrating dosimeter - it has been possible to assess, with some degree of accuracy, the overall body dose acquired by aircrew during their passage through a nuclear cloud. However, it is patent that several difficulties exist: film badges are in some circumstances directional, and though when positioned on the chest in the seated position give a near approximation of the whole body dose, they suffer from shielding from aircraft skin and components - dosimeters worn on the leg are undoubtedly liable to be affected by shielding - the "Charlie" meter positioned under the wireless operator's seat pan cannot be looked on as representative of the general body dose of the occupants, and is, more than likely, affected by considerable shielding from the aircraft and its equipment.

VARIATION IN CREW POSITION AND THE LIKELY EFFECT OF SHIELDING

General

All crew members are seated in ejector seats of steel construction, the back being particularly solid, incorporating much of the firing mechanism and built well above the head of the occupant in the manner of an old fashioned club armchair. Arm rests come to iliac crest level and the seat pan is particularly solid.

Pilot Position

Apparently the most exposed position. Anteriorly bounded by the instrument panel. Laterally instrument boards and aircraft skin to approximately elbow position, rear ejector seat and navigator's consol. Above perspex canopy.

Navigator

Anterior instrument consol. Left lateral instrument panel and aircraft skin Posterior bulkhead. Above aircraft skin.

Wireless Operator

Anterior part screened by navigator's consol. Right lateral instruments and aircraft skin, above aircraft skin.

Petrol Tank No. 1

Both navigator and wireless operator's positions are screened to some extent by this rear positioned tank, which holds 150 gallons.

Floor

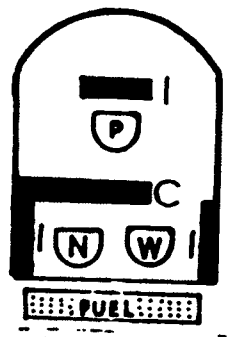
All positions are screened by the relatively stout floor and the outer skin (Note: the aircraft has a pressure hull, which renders it more solid than the conventional aircraft aluminium skin).

APPRAISAL OF SEATING POSITIONS IN RELATION TO SHIELDING

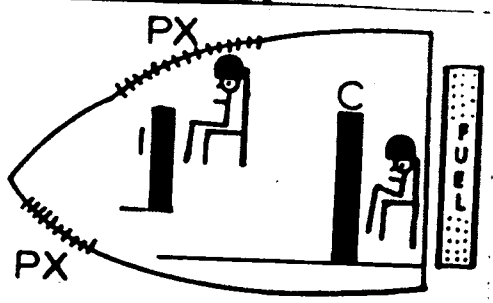
It is clear that the pilot would appear to be the most vulnerable crew member and that he receives little or any shielding, barring the perspex hood, from the waist upwards, the lower part of the body being shielded by the instruments and the ejector seat. The navigator on the other hand appears to enjoy the most shielding, while the wireless operator's situation is better than the pilot's but not as good as the navigator's. Thus in the Canberra B6 it can be envisaged that the two rear seated crew members have the benefit of considerable shielding from the aircraft and its components, while the pilot is much less favourably situated.

The sketches 1 and 2 below give some idea of the relative shielding in the three crew positions.

Sketch 1



Sketch 2

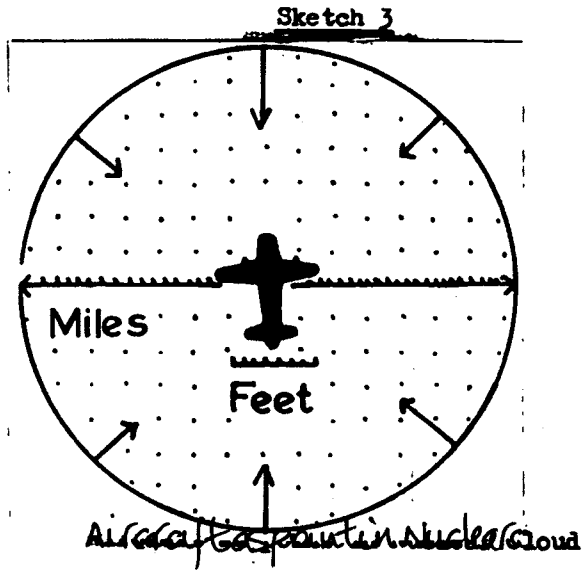


PX = Perspex Canopy
B = Bomb Aimer's Canopy

MECHANICS OF NUCLEAR CLOUD ON FILM BADGES

In view of the large size of the nuclear cloud in relation to the aircraft, it can, for practical purposes, be assumed that the aircraft is a point within a large diffuse source and that radiation will impinge on the aircraft from all directions.

Sketch 3



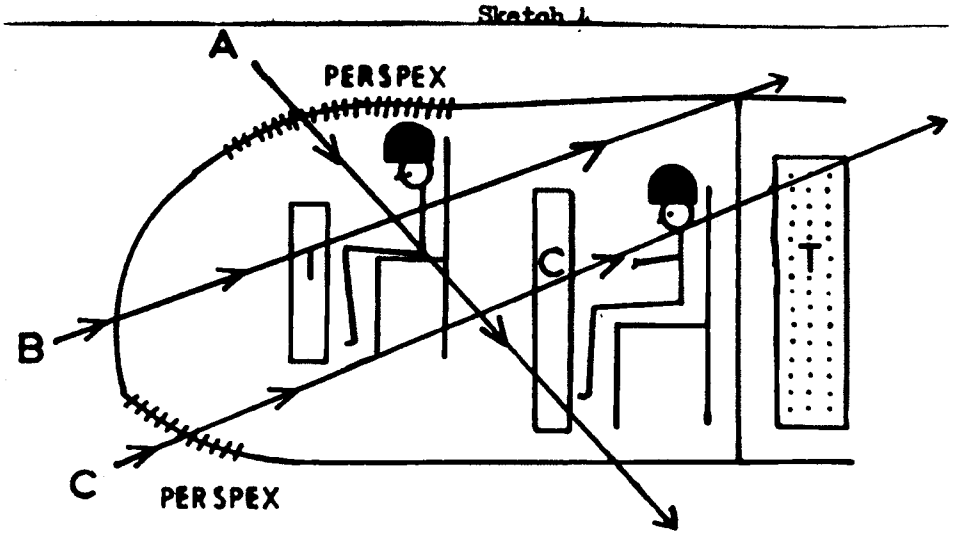
Note:
Title is:
Aircraft as point in Nuclear Cloud

However, if three theoretical rays are drawn passing through the aircraft cabin, it will be seen that certain rays will have a better chance of causing damage to the occupants than others, due to shielding from the aircraft components. In the sketch below it will be seen that rays A and B affect the pilot, while the navigator escapes and that C, though affecting the navigator, will have lost much of its energy due to the shielding effect of the consol.

Sketch 4

(Overleaf)

Sketch 1.



P = Perspex Canopy
B = Bomb Aimer's Canopy
I = Instrument Panel
C = Consol
T = No. 1 Fuel Tank

Consideration will show that a very large number of shielding factors can occur in a cockpit which is full of bulky instruments and equipment. Furthermore, backscatter can occur from all the equipment surfaces; however, as these are so numerous they may conveniently be neglected, as all occupants are at hazard from this diffusion.

AIRCRAFT MATERIALS AND SHIELDING

As has already been stated, shielding from the floor of the aircraft and ejector seats are common to all crew members, and can be considered as a constant; however, one very big difference occurs in that the pilot alone is shielded by a large area of perspex of considerable thickness, and this would be a most effective shield against beta radiation, and could in certain circumstances be superior to the outer skin, which shields the two rear crew members. Instrument consols are made of light steel racking with instruments bolted in position, and they are, when fully rigged, solid pieces of equipment which would provide very considerable shielding. The main consol is that of the navigator and completely covers his anterior aspect.

PHYSICAL CONSIDERATIONS AFFECTING FILM BADGES

Film badges are carried outside the flying clothing in the "V" area and are thus affected by the ambient temperature of the cockpit. In all sorties sampling is carried out at "height" and temperatures around zero are commonplace in the cockpit. Exposure of the film badge occurs at such low temperatures.

Film emulsion is standardised for exposure at temperatures within the 15 to 19° Centigrade range, and a correction of 0.3 r for every degree above or below the range should be made to obtain a correct assessment. In trials exposures during sampling runs it is reasonable to expect the film badges to read approximately 5% low due to the temperature drop.

Directional affect. A film badge exposes a broad area to the front, but sideways on is a relative knife edge, and clearly the chances of rays impinging are less in the sideways position. However, what rays strike the badge in this side position traverse a much greater distance in emulsion, and hence give an increased effect. It has been suggested by simple experiment that in the lateral position the effect on a film badge is 75% of that which it would be if the badge was presenting its face to a given source.

Clearly, as it is assumed that a cloud is homogenious and that the aircraft is a relative point source, a small proportion of rays impinging on the crew members' body in the laterial aspect will be underestimated by badges in the conventional position.

Chemical and light Affects. Error in film development can occur due to many reasons, in particular chemical impurities in solutions and poor agitation of the developing tank, giving uneven developer concentration. Small quantities of light

may actuate the emulsion through pinholes in the paper shielding.

PRELIMINARY CONSIDERATIONS

Though it must be admitted that film badges offer the simplest and cheapest method of assessment of aircrew dosage during cloud sampling coupled with a very low weight penalty, as opposed to other types of instruments, their accuracy as an indication of whole body dose may leave much to be desired.

Shielding in an aircraft is considerable and very varied in relation to the three crew positions, hence considerable variation will arise from this factor alone.

INITIAL EXPERIMENT

Experience has shown that the secondary sampling aircraft usually experience the highest dose rate as the controller (air) has gained experience from the primary sampler's dose rate (Charlie meter) and is thus more confident in holding the second aircraft in the cloud for the maximum safe period. Thus the initial experiment was carried out on personnel flying the Secondary sampler.

As it was suspected that the chest badge did not give a very fair approximation of the whole body dose, it was decided to use more badges per man in an atte to get more information. Placing of any number of badges on individuals was not possible, due to technical difficulties associated with aircrew clothing and ejec mechanism, and in lieu fixed positions in the aircraft were adopted, these being acceptable to the R.A.F. authorities.

Four P.M.3 badges were placed on the ejector seat in the following locations

1. Head rest 1 inch above head
2.) 3.) On arm rests upper surface
4. In seat pan 1 inch from testicles.

Care was taken to ensure that as little shielding affect as possible was giv by the ejector seat and that no equipment of any description shielded the badges. In addition to these badges the members were issued with the normal chest badges and dosimeters.

Figures derived from the Chest P.M.3 and 0 - 50 dosimeter

	Badge	Dosimeter
Pilot	13 r	13.5 r
Navigator	10.75 r	10 r
Wireless operator	10.75 r	15 r

Figures derived from the four special P.M.3 badges

	Head	L. Arm rest	R. Arm rest	Seat pan
Pilot	18.8 r	12.5 r	12.5 r	8.8 r
Navigator	17.0 r	11.1 r	11.0 r	7.6 r
Wireless operator	17.0 r	10.7 r	12.5 r	7.6 r

Time in Cloud 6 minutes
Time of entry after burst H + 49 m.
Height 51,000 feet
Charlie reading 10.6 r

Note: Conditions of gamma shine were not encountered

Pilot			Navigator			Wireless operator		
	18.8			17			17	
12.5	13	12.5	11	10.75	11.1	12.5	10.75	10.7
	8.8			7.6			7.6	

Key

Head Badge

Right Arm Chest Badge Left Arm

Testicular Badge

IMPLICATION

General

It will be seen that though the series is small a very considerable degree of agreement exists between all readings, with one exception, that being the dosimeter worn by the wireless operator. It is considered that this is, however, a leak affect due to the wet weather encountered on the trial - dosimeter discrepancy was noted in many other instances and proven to be due to leak.

As reliance has always, in previous trials, been placed on the single or double chest badge, it is interesting to note that this has given, in this series, readings which are consistently above those of the testicular badge. The safety factor being in the region of 50%, on an average, of the three positions of the crew.

The most striking feature is the fall-off in dose recorded between the head and the testicular badge. The distance between these badges being something not more than 2 feet 9 inches, yet a factor of 2 is seen in every set of readings. This clearly suggests that the rays penetrating the cabin were of a soft nature and that beta particles were probably absent, being excluded by the shielding offered by the aircraft hull.

Charlie Meter Reading

This reading is low in comparison to the head doses, but nevertheless approximates to the chest (whole body) dose and can be reckoned to give an indication of the general dose if a 10% addition is made to the reading. It should be noted that it had already been stated that the meter is in a relatively shielded position, which probably accounts for this discrepancy.

Head Doses

In view of the fact that the pilot appears to be very much more exposed than any other crew member, the 1.8 maximum difference (18.8 r to 17.0 r) suggests that the perspex canopy is a far more efficient shield than had been suspected. Nevertheless, the considerable higher general level of radiation to the head would appear a possible hazard in relation to the sensitive eye tissue. But as it appears beta radiation is largely absent from the cabin, this could perhaps be over emphasised, as experiment has suggested human eye tissue to be less sensitive than that of the animals which have been used experimentally.

Arm Rest Badges

Dosages follow the general pattern of the chest badge, suggesting thatlateral radiation is probably largely cut off by the shielding provided by the pressure hull and instruments. It is, however, surprising that the wireless operator's right arm should show a higher dose, as it would appear to be well shielded by instruments on the adjacent panel.

Testicular Badges

The very significantly lower levels are of interest and cheer in relation to the possibility of genetic damage and in all instances they are a quarter below the reading given by the "Charlie" meter, thus providing an inbuilt safety factor for the land and air controllers.

FURTHER INVESTIGATIONS

Though the figures quoted show mathematical agreement to a surprising degree, the series is, however, small and open to criticism from this fact, and further

xperiments on similar lines should be conducted.

4. In view of the possible sensitivity of ocular tissues, badges should be worn at eye level. The difference between eye level and the head badge which is situated at the vertex, is plus 6 inches, and it is more than likely that a fall-off will occur in this distance, short though it be.

The chest badge, being ventrally situated, should be supplimented by a badge on the dorsum in the region of T8 - 10. This would give a better idea of the "whole" body dose.

If possible a badge should be worn next to the skin to give an indication of the shielding effect provided by the flying overall and vent suit.

SUMMARY

Film badges (P.M.3) were placed in a roughly square configuration around three members of a cloud sampling crew in a Canberra B6.

Mathematical uniformity was observed between the separately placed badges and a factor of two was noted between badges situated respectively on the vertex and the testicle.

The integrating dosimeter (Charlie meter) was found to be in general agreement with the film badges, but to read approximately 10% low on the whole body dose.

Further readings are necessary in confirmation, and in particular to check dose received by ocular tissue.

A.W.R.E.
Health Physics.
Aldermaston.

[redacted]
M.A.,L.R.C.P.,M.R.C.S.

[redacted]

(24)

High Radiological Exposures
MoD—AWRE Trials

					Dose in R
1.					
2.					
3.					
4.					
5. a.					
b.					
6.	[redacted]	RAF	1958	GY	13
7.		RAF	1958	GY	13 ✓
8.		RAF	1958	GY	11
9.					
10.					
11.					
12.					
13.					
14.					

Y

The MoD Officers listed above had doses in excess of 10R recorded by their film badges, whilst carrying out Air Operations at AWRE Overseas Trials.

[redacted]

Supt. Health Physics Branch

28/6/1967

~~COVERING RESTRICTED~~

PWT/5 · From: [redacted], RAF

MINISTRY OF DEFENCE
1-6 Tavistock Square, LONDON W.C.1
Telephone: ~~EUSTON~~ [redacted]
01-387

(2)

Our reference: AF/10165/68/MA4a(RAF)
Your reference:

30th December 1969

Dear [redacted]

RADIATION SAFETY DURING WEAPONS TRIALS

1. For some time past I have been concerned that we had no narrative report of the health physics supervision of RAF personnel involved in the various weapons trials. There has been a considerable "oral tradition" that I have been able to use when dealing with pensions claims, but memories fade and senior staff retire.

2. Therefore, I asked [redacted] to prepare a report with the assistance of his colleagues at AWRE: I enclose a copy for your information. If you have any additional data to add to it, I would be pleased to receive them and to incorporate them in this "authorized version".

yours ever

[redacted]

[redacted]
Institute of Naval Medicine
Alverstoke
Gosport
Hants

[redacted]
Institute of Aviation Medicine
RAF Farnborough
Hants

Copy to: Branch Folder AF/RAD 1/MA 4a(RAF)

~~COVERING RESTRICTED~~

A BRIEF SKETCH OF THE MAIN RADIATION SAFETY PRECAUTIONS OBTAINING DURING THE UNITED KINGDOM NUCLEAR TRIALS. (RAF INVOLVEMENT.).

The objective of this paper is to provide a short non-technical summary of the UK Nuclear Trials, from inception to culmination, with special reference to the many steps that were taken to ensure that Royal Air Force personnel were subjected to no undue hasard from any form of ionising radiation. This paper is prepared, at a point in time, when it is still possible to obtain detailed information from persons who either initiated or were responsible for actioning radiation safety precautions or who can offer access to detailed health physics records, either official or in the form of personel operational diaries.

[redacted]

GRAP 15

K1431

834

Comments on Paper on Aircrew Doses

The intention of your paper is admirable, but I feel that one or two statements cannot go quite without some comment.

Page 1 - Past Development

In the word "initial" I know you mean Grapple trials, but I feel that this is a little unfair to A.W.R.E. as in all trials previous to Grapple itself badges are worn specifically as near to the heart as possible, and this has always been a deciding factor in film badge dosimetry which is intended to measure total body irradiation. Further, I am surprised to learn that P.M.1s. only were used on Grapple as previously and subsequently both P.M.1s. and P.M.3s. have been worn.

Page 1 - Last Paragraph, Line 2

I think 0.5 should be 5 r.

The question of pocket dosimeters being effected by humidity and dust has always been solved quite satisfactorily by sealing them in clear P.V.C. which, in the form of a bag, enabled dosimeters to be worn adjacent to the film badges. Again, I am surprised if this was not the practice on Grapple trial.

Perspex Screening

The exact thicknesses of perspex and aluminium in Canberras are what effects the relative screening properties of these two materials. My guess is that the lower absorption through perspex is more than offset by the necessary increase in thickness which I am sure it is necessary to use in order to gain mechanical strength, and therefore I should not be surprised to find that the perspex was at least as effective as normal aircraft skin in screening out gamma radiation.

Your results on the difference between film badges in different position I think, provide an excellent reason for placing the reliance on the film badge on the chest as this appears to give an excellent average dose to the whole body. The question of wearing a film badge next to the skin to give a indication of the shielding effect is possibly a good one, but you realise I hope that the doses measured by a film badge outside clothing including back-scatter from the body is by convention a measure of the dose to the bare body underclothing without backscatter.

[redacted]

[redacted]

Extn. [redacted]
20th October, 1958.

c.c. [redacted]

available.

AIRCREW TASKS.

1. Sampling.

The use of Canberra aircraft to fly through relatively recent nuclear clouds and collect samples of the radioactive debris was developed over the trial's period. Ultimately a squadron (No: 76.) of six Canberra aircraft were specifically earmarked for these duties. However servicability was of such a high order that only four of these aircraft had to be committed over the trial's period (i.e. 2 remained clean.).

The scientific objective was to collect a suitable sample of the fission products in specially designed apparatus attached to the exterior of the aircraft. The aircraft continued to fly in the nuclear cloud until a sufficiency of sample had been obtained or it was deemed prudent to exit to ensure that the crews did not receive an over exposure to radiation. The whole procedure was controlled both from the air and from the ground. All aircraft were pressure cabin type and as an additional precaution two large filters (Roughing and Fine filter) were interposed in the cabin air supply system. As a further precaution all crew members donned oxygen masks as soon as the aircraft entered the nuclear cloud and these remained in situ until landing.

A variety of other safety measures were obligators. These are listed below with brief descriptions :-

a. All participating aircrew were briefed on the problems, hasards and manner of conduct when flying in a nuclear cloud. Such briefings were carried out by members of AWRE and the squadron medical officers. The latter being members of RAF/AWRE and attached to the Health Physics Division. The squadron was not subjected to mass postings and experienced members were always available to assist new inexperienced aircrew. This concept ensured that expertees was not squandered - this did not obtain in many other RAF situations in the task force.

b. All entrant members of the squadron were subjected to a Radiation Medical examination on entry. Their continued good health was the direct responsibility of the squadron medical officers.

c. All aircrew were exhaustively exercised, under strict supervision, in the drills that were expected of them during sampling sorties. Further practice was carried out on all possible emergencies that might occur in which the covering of the exterior of the aircraft with adherent particulate could cause problems and possible hasard. Emergency health physics kits were carried on aircraft for the use of the crews if unscheduled landings occurred.

d. All sampling crews carried two film badges per man. As an additional precaution and to provide an immediate check an array of dosimeters were worn by each crew member. It

was usual to carry three covering, in decades, from 0 to 50 rontgens. In addition a large integrating ion chamber was fitted under the navigators seat which read out onto a large quadrant dial which was colour coded. The divisions were green - yellow - red. The interpretation was simple- green = insignificant dose yellow = dose mounting and exit time nearing Red = immediate exit from cloud.

e. An air sampler was installed in each aircraft to monitor the cabin air. The machines used were the well tried Vacanair which sample at approximately resting respiratory rate. High altitude non-sparking brushes were fitted as a flying requirement. No significant levels were ever recorded in cabins though considerable amounts of particulate materials were known to have been stopped in the filters.

f. On landing crews were assisted out of the aircraft after they had donned overshoes and gloves. Other flying equipment was placed in polythene bags. Exit of the crews was accomplished by a non-touch drill developed between the crews and their ground helpers. The aircrew were then passed through a formal decontamination and health control centre. Over the trials period no significant contamination was ever detected on any of the sampling aircrew or their equipment.

g. A trial's limit for wholebody exposure of aircrew was fixed after discussion between RAF and civilian appropriate authorities. The limit was cumulative against the time period between individual sorties. If the upper limit was exceded in any single sortie the crew or crew member was precluded from any further sampling duties. Records of such doses are held at AWRE, Health Physics branch.

SUMMARY OF RAF PERSONNEL EXPOSURES OVER THE TRIAL'S PERIOD.

The significant exposure of any RAF personnel, with a few predictable exceptions, was unheard of over the test period. The sampling aircrew and sample handlers received significant doses. These were essentially to predicted levels which had received official waivers.

The rarity of doses is due to two factors. Firstly very few persons actually came incontact with radiation and secondly those who did were always under rigid supervision and had received adequate training.

The few RAF personnel who received significant doses have their records preserved either in the office of the Director of Health and Research, Medical Directorate or in the Film Badge Office of AWRE Health Physics Division.

[redacted]

AWRE. Aldermaston.

[redacted]

Consultant in Radiobiology. RAF.

[redacted]

SFS/OEL/UAB/1(P)
16 March 1982
Provisional Issue

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE ALDERMASTON

SFS/OEL/UAB/1(P)

Listing of Persons at UK Overseas Defence Nuclear Experimental Programmes
UK (Royal Air Force) (Provisional Issue)
Part 1 (A - L)

Compiled at the direction of
SFS/MOD(PE)AWRE

by

[redacted]

AWRE Aldermaston
Berkshire

[redacted]

[redacted]

SFS/OEL/UAB/1(P)
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16 MARCH 1982

PROVISIONAL ISSUE

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE,ALDERMASTON

SFS/OEL/UAB/1(P)

LISTING OF PERSONS AT UK OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES

UK(ROYAL AIR FORCE);(PROVISIONAL ISSUE)

PART 1 (A - L)

COMPILED,AT THE DIRECTION OF
SFS/MOD(PE)AWRE,

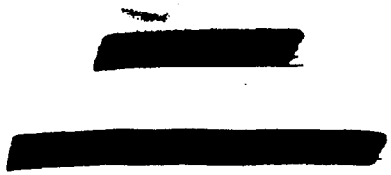
BY

[redacted]

[redacted]
MOD(PE)AWRE,ALDERMASTON
READING,RG7 4 PR,
BERKSHIRE,UK
16 MARCH 1982

COMPILED AT MOD(PE)AWRE
ALDERMASTON FROM UK SOURCES
OF INFORMATION AVAILABLE AND
REVIEWED UP TO 15 MARCH 1982

[redacted]



SFS/OEL/UAB/1(P)

THIS DOCUMENT CONTAINS IN CONFIDENCE A SUMMARY PROVISIONAL LISTING OF NAMES AND RELEVANT ASSOCIATED DATA,OBTAINED FROM AVAILABLE UK INFORMATION SOURCES WHICH WERE ACCESSIBLE TO AND REVIEWED BY AWRE STAFF UP TO 15 MARCH 1982,FOR PERSONS WHO THE INFORMATION INDICATES WERE OR MAY HAVE BEEN CITIZENS OF THE UK AND MEMBERS OF THE UK ROYAL AIR FORCE TAKING PART IN PROGRAMMES OF UK OVERSEAS FIELDEXPERIMENTS,ASSOCIATED WITH UK DEFENCE(NUCLEAR WEAPONS)RESEARCH AND DEVELOPMENT PROJECTS,CARRIED OUT IN AUSTRALIA,IN THE PACIFIC OCEAN ZONE OR ELSEWHERE.

THE LISTING IS NOT CLAIMED TO BE FREE FROM ERRORS,INCORRECT ASSERTIONS OR OMISSIONS AND THE ATTRIBUTION OR NON-ATTRIBUTION OF UK CITIZENSHIP OR SERVICE ASSOCIATION TO A PARTICULAR NAME MAY NOT, IN SOME CIRCUMSTANCES,BE CORRECT:THE INFORMATION AVAILABLE WAS SPARSE,OF VERY VARIED QUALITY,AND OFTEN AMBIGUOUS OR INDETERMINATE.

THIS DOCUMENT AND ANY ENTRY OR LACK OF ENTRY OR OF INFORMATION THEREIN IS NOT AND DOES NOT CONSTITUTE AND MAY NOT BE CONSTRUED OR IMPLIED TO BE A FORMAL SUMMARY RECORD,A MANDATORY RECORD OR OTHER RECORD OF INDIVIDUAL DOSES OR OF EXPOSURES TO IONISING RADIATIONS.

Run 5

Time of entry = H + 113 min. Time of exit = H + 116 min.

Instant	1	2	3	4	5	6	7	8	9	10
Romeo	85	90	90	80	70	70	80	70	60	60
Charlie	6.2	6.5	6.6	6.7	6.8	6.9	7.0	7.2	7.3	7.3
Salmon	50+	50+	50+	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 7.9

Run 6

Time of entry = H + 119 min. Time of exit = h + 120 min.

Instant	1	2	3	4	5
Romeo	60	60	60	40	32
Charlie	8.1	8.2	8.4	8.4	8.4
Salmon	50+	50+	50+	50+	50+

Final Charlie = 8.5

- - - - - - - - - - -

[redacted]

[redacted]

NOTES ON THE LISTING

1.THE SOURCES CONSULTED IN COMPILING THIS SUMMARY,WITH THE ABBREVIATIONS USED THEREIN,WERE

AHB = AIR HISTORICAL BRANCH RECORDS,MOD(AFD)
ARMY HB = ARMY HISTORICAL BRANCH RECORDS,MOD
HP = AWRE HEALTH PHYSICS DATA
L = RN SHIPS LEDGERS,MOD(NAVY)
MHP = MARALINGA MONTHLY HEALTH PHYSICS REPORTS,AUST.CXRL
MISC = PERSONAL SOURCES,WRITTEN OR VERBAL
ORB = RAF SQUADRON OPERATIONAL REPORT BOOKS,MOD(AFD)
P = AWRE PLANNING DOCUMENTS
R = AWRE OVERSEAS TRAVEL REGISTER
R-W = RAF RADIOBIOLOGIST'S NOTES
TR = AWRE T SERIES REPORTS

2.ALL UK(AWRE)OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES HAVE BEEN INCLUDED

3.ABBREVIATIONS USED FOR OPERATIONS AND ORGANISATIONAL GROUPS ARE DETAILED IN SFS/OEL/GB/1(P)

4.RADIATION DOSES ARE GIVEN UNDER TOTAL DOSE IN MILLIREM. COLUMN G IS THE GAMMA COMPONENT,COLUMN AGG IS THE GAMMA + BETA AGGREGATE,LOCALISED GAMMA DOSES ARE GIVEN WHERE APPROPRIATE,OTHER NOTES ARE ALSO PLACED UNDER THIS HEADING.

NO ENTRY,NIL OR BELOW X IN THE DOSE COLUMN INDICATES THAT THE MEASURED FILM DENSITY ON ONE OR MORE FILMS WAS AT THE THRESHOLD LEVEL,OR THAT THE PERSON CONCERNED WAS ENGAGED IN WORK WHERE NO FILM WAS ISSUED OR NEEDED. ? FOLLOWING A DOSE FIGURE INDICATES A DOUBT EXISTS OF ATTRIBUTION OF DOSE

ABBREVIATIONS USED ARE LH = LEFT HAND,RH = RIGHT HAND,H = HEAD,W = WRIST,F D = FILM DAMAGED,F M = FILM MISSING,N/A = FILM NOT RETURNED,T = TOLERANCES

5.100 MILLIREM(mREM) = 1 MILLISIEVERT(mSv) AND IS APPROXIMATELY NUMERICALLY THE SAME AS 100 MILLIROENTGEN(mR)

6.BRACKETED NUMBERS AFTER ENTRIES HAVE THE FOLLOWING MEANINGS :-

(1)QFD = QUARTZ FIBRE DOSIMETER,THE FILM BADGE DOSES WERE REPORTED AS BEING APPROXIMATELY ONE HALF THIS FIGURE

(2)DOSES LISTED ARE THOSE FROM THE HP FILES COMPILED DURING THE OPERATIONS.OTHER CORRESPONDENCE SUGGESTS THERE WAS SOME LATER CONFUSION BETWEEN GRAPPLE AND ANTLER DOSES AND BETWEEN QUARTZ FIBRE AND FILM BADGE DOSES.

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y		1958					L
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	350			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y		1958					L

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	58 SQ	21/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	19/1/58	13/4/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	10000			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	1958		20			HP

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	1958					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	2/4/58	1/6/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	13000			ORB,HP,R-W

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y		1958					L
[redacted]	RAF	[redacted]	GRAPPLE Y	511 SQ	19/1/58	22/4/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	13000			ORB,HP

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	450			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	24 SQ	21/4/58	25/7/58				ORB

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	511 SQ	19/1/58	21/3/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	26/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	22 SQ	19/2/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58				ORB,HP
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	10750			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	15/3/58					ORB,HP

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	26/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y		1958					L
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	15/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	19/5/58	10500			ORB,HP
[redacted]	RAF	[redacted]	GRAPPLE Y	49 SQ	26/3/58	6/5/58				ORB

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
										HP
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	99 SQ	13/2/58	18/4/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	10750			ORB,HP,R-W

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	49 SQ	23/3/58	4/5/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	22/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	49 SQ (P)	1958					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	49 SQ		27/4/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	340			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	1958					ORB

[redacted]

SFS/OEL/UAB/1(P)
16 March 1982
Provisional Issue

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE ALDERMASTON

SFS/OEL/UAB/1(P)

Listing of Persons at UK Overseas Defence Nuclear Experimental Programmes
UK (Royal Air Force) (Provisional Issue)
Part 2 (M - Z)

Compiled at the direction of
SFS/MOD(PE)AWRE

by

[redacted]

AWRE Aldermaston
Berkshire

[redacted]

[redacted]

SFS/OEL/UAB/1(P)

16 MARCH 1982

PROVISIONAL ISSUE

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE, ALDERMASTON

SFS/OEL/UAB/1(P)

LISTING OF PERSONS AT UK OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES

UK(ROYAL AIR FORCE);(PROVISIONAL ISSUE)

PART 2 (M - Z)

COMPILED, AT THE DIRECTION OF
SFS/MOD(PE)AWRE,

BY

[redacted]

[redacted]
MOD(PE)AWRE, ALDERMASTON
READING, RG7 4 PR,
BERKSHIRE, UK
16 MARCH 1982

COMPILED AT MOD(PE)AWRE
ALDERMASTON FROM UK SOURCES
OF INFORMATION AVAILABLE AND
REVIEWED UP TO 15 MARCH 1982

[redacted]

[redacted]

SFS/OEL/UAB/1(P)

THIS DOCUMENT CONTAINS IN CONFIDENCE A SUMMARY PROVISIONAL LISTING OF NAMES AND RELEVANT ASSOCIATED DATA.OBTAINED FROM AVAILABLE UK INFORMATION SOURCES WHICH WERE ACCESSIBLE TO AND REVIEWED BY AWRE STAFF UP TO 15 MARCH 1982,FOR PERSONS WHO THE INFORMATION INDICATES WERE OR MAY HAVE BEEN CITIZENS OF THE UK AND MEMBERS OF THE UK ROYAL AIR FORCE TAKING PART IN PROGRAMMES OF UK OVERSEAS FIELDEXPERIMENTS,ASSOCIATED WITH UK DEFENCE(NUCLEAR WEAPONS)RESEARCH AND DEVELOPMENT PROJECTS,CARRIED OUT IN AUSTRALIA,IN THE PACIFIC OCEAN ZONE OR ELSEWHERE.

THE LISTING IS NOT CLAIMED TO BE FREE FROM ERRORS,INCORRECT ASSERTIONS OR OMISSIONS AND THE ATTRIBUTION OR NON-ATTRIBUTION OF UK CITIZENSHIP OR SERVICE ASSOCIATION TO A PARTICULAR NAME MAY NOT, IN SOME CIRCUMSTANCES,BE CORRECT:THE INFORMATION AVAILABLE WAS SPARSE,OF VERY VARIED QUALITY,AND OFTEN AMBIGUOUS OR INDETERMINATE.

THIS DOCUMENT AND ANY ENTRY OR LACK OF ENTRY OR OF INFORMATION THEREIN IS NOT AND DOES NOT CONSTITUTE AND MAY NOT BE CONSTRUED OR IMPLIED TO BE A FORMAL SUMMARY RECORD,A MANDATORY RECORD OR OTHER RECORD OF INDIVIDUAL DOSES OR OF EXPOSURES TO IONISING RADIATIONS.

[redacted]

NOTES ON THE LISTING

1.THE SOURCES CONSULTED IN COMPILING THIS SUMMARY,WITH THE ABBREVIATIONS USED THEREIN,WERE

AHB = AIR HISTORICAL BRANCH RECORDS,MOD(AFD)
ARMY HB = ARMY HISTORICAL BRANCH RECORDS,MOD
HP = AWRE HEALTH PHYSICS DATA
L = RN SHIPS LEDGERS,MOD(NAVY)
MHP = MARALINGA MONTHLY HEALTH PHYSICS REPORTS,AUST.CXRL
MISC = PERSONAL SOURCES,WRITTEN OR VERBAL
ORB = RAF SQUADRON OPERATIONAL REPORT BOOKS,MOD(AFD)
P = AWRE PLANNING DOCUMENTS
R = AWRE OVERSEAS TRAVEL REGISTER
R-W = RAF RADIOBIOLOGIST'S NOTES
TR = AWRE T SERIES REPORTS

2.ALL UK(AWRE)OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES HAVE BEEN INCLUDED

3.ABBREVIATIONS USED FOR OPERATIONS AND ORGANISATIONAL GROUPS ARE DETAILED IN SFS/OEL/GB/1(P)

4.RADIATION DOSES ARE GIVEN UNDER TOTAL DOSE IN MILLIREM. COLUMN G IS THE GAMMA COMPONENT,COLUMN AGG IS THE GAMMA + BETA AGGREGATE,LOCALISED GAMMA DOSES ARE GIVEN WHERE APPROPRIATE,OTHER NOTES ARE ALSO PLACED UNDER THIS HEADING.

NO ENTRY,NIL OR BELOW X IN THE DOSE COLUMN INDICATES THAT THE MEASURED FILM DENSITY ON ONE OR MORE FILMS WAS AT THE THRESHOLD LEVEL,OR THAT THE PERSON CONCERNED WAS ENGAGED IN WORK WHERE NO FILM WAS ISSUED OR NEEDED. ? FOLLOWING A DOSE FIGURE INDICATES A DOUBT EXISTS OF ATTRIBUTION OF DOSE

ABBREVIATIONS USED ARE LH = LEFT HAND,RH = RIGHT HAND,H = HEAD,W = WRIST,F D = FILM DAMAGED,F M = FILM MISSING,N/A = FILM NOT RETURNED,T = TOLERANCES

5.100 MILLIREM(mREM) = 1 MILLISIEVERT(mSv) AND IS APPROXIMATELY NUMERICALLY THE SAME AS 100 MILLIROENTGEN(mR)

6.BRACKETED NUMBERS AFTER ENTRIES HAVE THE FOLLOWING MEANINGS :-

(1)QFD = QUARTZ FIBRE DOSIMETER,THE FILM BADGE DOSES WERE REPORTED AS BEING APPROXIMATELY ONE HALF THIS FIGURE

(2)DOSES LISTED ARE THOSE FROM THE HP FILES COMPILED DURING THE OPERATIONS.OTHER CORRESPONDENCE SUGGESTS THERE WAS SOME LATER CONFUSION BETWEEN GRAPPLE AND ANTLER DOSES AND BETWEEN QUARTZ FIBRE AND FILM BADGE DOSES.

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	5500			ORB,HP,R-W
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	15/3/58					ORB

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	WF	1958					P
[redacted]	RAF	[redacted]	GRAPPLE Y	WF	1958		25			HP
[redacted]	RAF	[redacted]	GRAPPLE Y	511 SQ	1/3/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	1/2/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	380			ORB,HP

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	1958					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	1/2/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	24 SQ	21/4/58	9/8/58				ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	7500			ORB,HP
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ		12/5/58				ORB

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	1958		850			HP
[redacted]	RAF ?		GRAPPLE X or Y	76 SQ	1957/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	70			ORB,HP
[redacted]	RAF	[redacted]	GRAPPLE Y	58 SQ	1958					ORB

[redacted]

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[redacted]	RAF	[redacted]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	5000			ORB,HP
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	9/2/58					ORB
[redacted]	RAF	[redacted]	GRAPPLE Y	240 SQ	9/2/58					ORB